

CLAIMS:

1. A method of concurrently encapsulating OLED devices against moisture penetration, comprising:

- 5 a) providing a rigid substrate or a flexible substrate;
- b) forming a plurality of laterally spaced OLED devices on the substrate wherein each OLED device includes a display area and one or more electrical interconnect areas for electrically addressing the display area;
- 10 c) forming a polymer layer over the OLED devices and over the substrate surrounding the OLED devices;
- d) depositing in a first pattern a particular inorganic dielectric material over the polymer layer and in alignment with the display area of each OLED device to form a first dielectric layer at least over such display area, and wherein the inorganic dielectric material is not deposited in at least a portion of 15 the electrical interconnect areas;
- e) removing the polymer layer by dry etching to expose the substrate and the one or more electrical interconnect areas while retaining the polymer layer over the display area of each OLED device due to an etching resistance of the first dielectric layer;
- 20 f) depositing in a second pattern the particular dielectric material or a different inorganic dielectric material and in alignment with the display area of each OLED device to form a first dielectric encapsulation layer over the first dielectric layer and over sidewalls of the first dielectric layer and of the polymer layer, thereby providing a plurality of encapsulated OLED devices 25 and permitting electrical access to outermost portions of the one or more electrical interconnect areas of each OLED device; and
- g) singulating the OLED devices from the substrate to provide a plurality of individual encapsulated devices.

2. The method of claim 1 wherein c) through f) are repeated one or more times prior to g).

3. The method of claim 1 wherein a) includes providing the 5 rigid substrate in the form of a moisture impermeable plate of a material selected from glass, metal, and ceramic materials.

4. The method of claim 1 wherein a) includes providing the 10 flexible substrate in the form of a moisture permeable plastic material selected from polymer materials.

5. The method of claim 4 wherein a) further includes
15 i) forming at least one inorganic dielectric base layer over a surface of the flexible substrate;
ii) forming at least one base assembly of layers over the base layer, forming the at least one base assembly by:
20 l) forming a polymer layer over the base layer;
 m) depositing in a first pattern a particular inorganic dielectric material or a particular metal material over the polymer layer and in alignment with OLED devices to be formed to form a first dielectric layer or metal layer aligned with such OLED devices to be formed;
25 n) removing the polymer layer by dry etching to expose the at least one dielectric base layer while retaining the polymer layer under the first dielectric layer or metal layer due to an etching resistance of the first dielectric layer or metal layer; and
 o) depositing in a second pattern the particular dielectric material or a different inorganic dielectric material and in alignment with the first pattern of the first dielectric layer or the metal layer to form a first

dielectric encapsulation layer over the first dielectric layer or metal layer and over sidewalls of the first dielectric layer or metal layer and of the polymer layer; and

p) forming the plurality of laterally spaced

OLED devices over the first dielectric encapsulation layer.

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6. The method of claim 1 wherein b) includes forming a plurality of top-emitting or bottom-emitting OLED devices.

7. The method of claim 5 further including forming passive matrix or active matrix OLED devices.

8. The method of claim 1 wherein c) includes forming the polymer layer by condensing polymer material from a vapor phase in a chamber held at a reduced pressure.

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9. The method of claim 1 wherein d) includes depositing the particular inorganic dielectric material by condensing such material from a vapor phase through openings in a shadow mask with the openings corresponding to the first pattern, and in a chamber held at a reduced pressure.

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10. The method of claim 1 wherein e) includes removing the polymer layer by subjecting the layer to a reactive gas stream containing oxygen, and in a chamber held at a reduced pressure.

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11. The method of claim 1 wherein f) includes depositing the inorganic dielectric material by condensing such material from a vapor phase through openings in a shadow mask with the openings corresponding to the second pattern, and in a chamber held at a reduced pressure.

12. The method of claim 5 wherein a) includes forming the at least one dielectric base layer by condensing inorganic dielectric material from a vapor phase in a chamber held at a reduced pressure.

5 13. The method of claim 2 wherein b) includes forming a plurality of top-emitting OLED devices having a transparent cathode electrode or transparent cathode electrodes.

10 14. The method of claim 5 wherein a) includes forming the at least one dielectric base layer as a transparent layer over the surface of a transparent flexible substrate, and b) includes forming at least one transparent base assembly of layers, and c) includes forming a plurality of bottom-emitting OLED devices having anode electrodes at least portions of which are transparent.

15 15. A plurality of laterally spaced encapsulated top-emitting or bottom-emitting OLED devices formed on a rigid substrate and made in accordance with the method of claim 1.

20 16. A plurality of laterally spaced encapsulated top-emitting or bottom-emitting OLED devices formed over an encapsulated flexible polymer substrate and made in accordance with the method of claim 5.

17. A method of concurrently encapsulating OLED devices against moisture penetration, comprising:

25 a) providing a rigid substrate or a flexible substrate;
b) forming a plurality of laterally spaced OLED devices on the substrate wherein each OLED device includes a display area and one or more electrical interconnect areas for electrically addressing the display area;
c) forming a polymer layer over the OLED devices and over
30 the substrate surrounding the OLED devices;

- d) depositing in a first pattern a particular metal material over the polymer layer and in alignment with the display area of each OLED device to form a metal layer at least over such display area, and wherein the metal material is not deposited in at least a portion of the electrical interconnect areas;
- 5 e) removing the polymer layer by dry etching to expose the substrate and the one or more electrical interconnect areas while retaining the polymer layer over the display area of each OLED device due to an etching resistance of the metal layer;
- f) depositing in a second pattern an inorganic dielectric material in alignment with the display area of each OLED device to form a first dielectric encapsulation layer over the metal layer and over sidewalls of the metal layer and of the polymer layer, thereby providing a plurality of encapsulated OLED devices and permitting electrical access to outermost portions of the one or more electrical interconnect areas of each OLED device; and
- 10 g) singulating the OLED devices from the substrate to provide a plurality of individual encapsulated devices.

- 18. The method of claim 17 wherein a) includes:
 - i) providing a flexible substrate in the form of a moisture permeable plastic material selected from polymer materials.
 - 20 ii) forming at least one inorganic dielectric base layer over a surface of the flexible substrate;
 - iii) forming at least one base assembly of layers over the base layer, forming the at least one base assembly by:
 - 25 l) forming a polymer layer over the base layer;
 - m) depositing in a first pattern a particular inorganic dielectric material or a particular metal material over the polymer layer and in alignment with OLED devices to be formed to form a first dielectric layer or metal layer aligned with such OLED devices to be formed;

n) removing the polymer layer by dry etching to expose the at least one dielectric base layer while retaining the polymer layer under the first dielectric layer or metal layer due to an etching resistance of the first dielectric layer or metal layer; and

5 o) depositing in a second pattern the particular dielectric material or a different inorganic dielectric material and in alignment with the first pattern of the first dielectric layer or the metal layer to form a first dielectric encapsulation layer over the first dielectric layer or metal layer and over sidewalls of the first dielectric layer or metal layer and of the polymer layer; and

10 d) forming the plurality of laterally spaced OLED devices over the first dielectric encapsulation layer

19. A method of encapsulating an OLED device against moisture penetration, comprising:

15 a) providing a substrate having a surface;

b) forming an OLED device over a portion of the surface of the substrate wherein the OLED device includes a display area and one or more electrical interconnect areas for electrically addressing the display area, and wherein there remains a free surface area of the substrate not occupied by the

20 display device;

c) forming a polymer layer over both the OLED device and the free surface area of the substrate;

d) depositing in a first pattern an inorganic layer over the polymer layer such that all of the polymer layer in the display area is covered by the inorganic layer, and at least a portion of the polymer layer in the electrical interconnect area and at least a portion of the polymer layer over the free surface area of the substrate is not covered with the inorganic layer;

25 e) removing the polymer layer in areas not covered by the inorganic layer to produce a patterned polymer layer; and

f) depositing in a second pattern an inorganic dielectric layer which extends at least over the sidewalls of the inorganic layer and over the sidewalls of the patterned polymer layer.

5 20. The method of claim 19 wherein e) is accomplished by dry etching.

10 21. The method of claim 19 wherein c) through f) are repeated one or more times.

15 22. An OLED display device comprising:
a) a substrate having a surface;
b) an OLED device provided over a portion of the surface of the substrate, wherein the OLED device comprises a display area and an electrical interconnect area;
c) a first patterned polymer layer extending over the entire display area but not over at least a portion of the electrical interconnect area and not over at least a portion of the surface of the substrate that is not occupied by the OLED device; and

20 25 d) a first inorganic dielectric layer assembly containing a patterned inorganic layer provided over the top surface of the patterned polymer layer and in alignment with the patterned polymer layer, and an inorganic dielectric layer provided over the inorganic layer and extending over the sidewalls of the inorganic layer and polymer layer, wherein at least a portion of the electrical interconnect area is not covered by the inorganic dielectric layer.

23. The device of claim 22 further including:
e) a second polymer layer provided over the first inorganic dielectric assembly in substantially the same pattern as the first polymer layer; and

f) a second inorganic dielectric layer assembly provided over the second polymer layer in substantially the same pattern as the first dielectric layer assembly.